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Historical review (1994-1998) and assessment of the 1999 exploratory snow crab (*Chionoecetes opilio*) fishery off southwestern Nova Scotia (NAFO Division 4X)

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ABSTRACT

The commercial exploitation and management framework for the exploratory NAFO Division 4X fishery for snow crab, *Chionoecetes opilio*, has grown from the sporadic trapping that began in 1994 to the current development phase with four exploratory licenses.

The 1999 total landings in southwestern Nova Scotia (SWNS) were 215% higher than those of 1998. There was a 53% increase in the seasonal catch-per-unit-of-effort (CPUE) and a similar level in total fishing effort compared to 1998.

A comprehensive trap survey was carried out in SWNS in 1999 in cooperation with the participating fishermen to this exploratory fishery. The survey showed that the distribution of adult crabs was limited to only two areas and that there was a full range of carapace conditions. However, 85% were older than carapace condition 3. Only 3 females were found, all were multiparous females carrying new eggs.

RÉSUMÉ

Le régime d'exploitation commerciale et de cadre de gestion de la pêche exploratoire du crabe des neiges, *Chionoecetes opilio*, dans la division 4X de l'OPANO est passé d'une pêche au casier sporadique, qui a débuté en 1994, à l'étape actuelle du développement avec quatre permis de pêche exploratoire.

Les débarquements totaux de 1999 en provenance du sud-ouest de la Nouvelle-Écosse («SWNS») ont été de 215 % supérieurs à ceux de 1998. Comparativement à 1998, les prises saisonnières par unité d'effort (CPUE) ont augmenté de 53 % et il en est de même pour l'effort de pêche total.

Un relevé détaillé au casier a été réalisé dans le «SWNS» en 1999 en collaboration avec les pêcheurs participant à la pêche exploratoire. Le relevé a montré que la répartition des crabes adultes était limitée à seulement deux zones et que la gamme des stades de condition de carapace était complète. Par ailleurs, 85 % des individus étaient plus âgés que le stade 3. Seulement 3 femelles ont été capturées et il s'agissait de multipares portant de nouveaux œufs.

INTRODUCTION

Two issues were raised at the last Maritime Regional Advisory Process for snow crab stock that was held at the Gulf Fisheries Center, Moncton, N.B., in January 21 – 22, 1999. The first one concerned the fact that this exploratory fishery has been focussed on newly discovered fishing grounds but was not conducting a systematic search of the entire 4X Area (NAFO Division 4X; also known as CFA-27; Fig. 1). The second issue was that a proper evaluation of the snow crab stock status for Area 4X was required. Until 1999, the stock assessment of the 4X fishery was marginally included in the eastern Nova Scotia stock assessment (Biron et al. 1999). There is a need from the Department of Fisheries and Oceans (DFO) Managers and 4X fishermen to examine this exploratory fishery for its potential to become a permanent fishery.

It is with these objectives in mind that all historical data presented in previous eastern Nova Scotia snow crab stock assessment documents have been reviewed and are presented in this document as an historical background for the 1999 stock assessment. In addition a trap survey covering most of the main surface of Area 4X was realized in 1999. The objectives were to systematically verify the presence or absence of snow crab in that area and to examine the quality and quantity of the snow crab caught. This was the first time that biological data was collected from this area.

BIOLOGICAL BACKGROUND

Snow crab (*Chionoecetes opilio*) is a crustacean with a flat almost circular body and five pairs of spider-like legs. The hard outer shell is periodically shed in a process called molting. After molting, crab have a soft shell for a period of time and are called soft-shelled crab. Unlike lobster, male and female snow crab do not continue to molt throughout their lives. Females stop growing after the molt in which they acquire a wider abdomen for carrying eggs. This occurs at shell widths less than 95 mm. Male snow crab stop growing after the molt in which they acquire relatively large claws on the first pair of legs. This can occur at shell widths as small as 40 mm. Female crab produce eggs that are carried beneath the abdomen for approximately 2 years. The eggs hatch in late spring and the tiny newly hatched crab larvae spend 12-15 weeks free floating in the water. At the end of this period, they settle on the bottom. It then takes at least 8-9 years for snow crab males to reach legal size.

Squires (1990) describe the range of distribution of this species in the western Atlantic from Greenland to the Gulf of Maine at depth ranging between 20 and 310 m, but mostly from 70 to 280 m. Typical fishing depths off southwestern Nova Scotia are 90 m to 180 m. The records of distribution (Squires 1990) clearly indicate that exploratory Area 4X is located at the most southerly limit for the distribution of this species. Different sources indicate that no snow crab have been captured on Georges Bank (NAFO Area 5ZE, located immediately west to Area 4X)(Squires 1990; Tremblay 1997).

DESCRIPTION OF THE FISHERY

Harvesting of snow crab off the southwestern coast of Nova Scotia (Fig. 1) began in 1994. A draw was held to allocate four licenses and create an eligibility list. In August 1994, the four approved license holders were issued a license condition for 1994 which included a 30 trap limit, no females retained, snow crab male size greater than 95 mm of carapace width (CW), by-catch of Jonah crab (*Cancer borealis*) allowed, and exploratory crab logbooks to be submitted.

In 1995 all licenses were renewed and issued by February 1995. Condition of license changed as the license holders were allowed 100 traps of which 30 could be 6 feet in diameter instead of the standard 4 feet used. The fishery started in March 1995 and by-catch of Northern Stone crab (*Lithodes maja*) was allowed.

In 1996, three of the four licenses were renewed. In August, one license was issued to a replacement fisherman chosen from the eligibility list. License conditions issued February 14, 1996 stipulated an increase in trap limit to 250 of which 30 could be the larger-size traps. By-catches of Jonah crab and Northern Stone crab were again allowed, but the size limits at 130 mm and 95 mm CW, respectively, were added. Traps required to have a biodegradable panel and 10% dockside monitoring (DMP) was required. Performance criterion (i.e. minimum number of fishing days each year required by license holders to keep owning their permits) was introduced to the fishery and set at 18 sea days per year, which was based on 10% of the available fishing days in the previous year's season.

All four licenses were renewed in 1997 and the license conditions were issued March 1, 1997. The only major change from the 1996 license was an increased coverage to DMP to 20%. Only two license holders fished, one of whom directed for Jonah crab instead of snow crab.

In 1998, Jonah crab was dropped from allowed by-catch species to this exploratory snow crab fishery, while DMP coverage remained at 20% as required by the developing species policy now in use in the Region. A higher than usual concentration of snow crab was found along the NAFO fishing boundary 4W/4X, on the 4X side. This resulted in the relocation of the fishing effort of three fishermen to that area from the fishing grounds surrounding Brown, Baccaro and Roseway Banks. The fourth fisherman maintained his exploratory fishing activity as usual in the Roseway Basin area. Therefore, the trap limit was reduced to a maximum of 30 large traps in Halifax and Lunenburgh Counties during the 1998 fishery, due to the high catch rates and concentration of fishing activity in this area, combined with the concern being raised by local residents regarding gear conflict. Furthermore, the overall limit of 250 traps was reduced to 175, of which 30 could be large-sized ones.

MATERIALS AND METHODS

Landings, catch rate and effort

For 1994 and 1995, data on landings and fishing effort were obtained from the mandatory exploratory crab logbooks. The original completed logs were compiled by DFO Science, Moncton, N.B.. From 1996 to 1999, data on landings and fishing effort were obtained from the mandatory logbook completed by all fishermen for both dockside monitoring and the scientific database. Copies of the original completed logs and the compiled electronic database were obtained from the Statistic Division of the Maritimes Region of the Department of Fisheries and Oceans. Thereafter, total seasonal landings for each year were obtained from revised preliminary report produced by the Statistic Division, and may slightly differ from results presented in the Stock Status Report for each of those years. All fishermen submitted their logs, but not all logs were usable; some have one or more missing or erroneous values such as missing number of trap used or incomprehensive fishing position. This is more of a problem in 1996 and 1997 because mandatory logbooks of the time did not require any information on the number of trap fished. In 1999, over 95% of the logs received had complete information.

Landings - Total landings are the sum of landings from the logs received for Area 4X. The geographic distribution of landings was presented as a sum of total landings within each 10' latitude by 10' longitude grid (10 X 7 nautical miles grid). The fishing positions were taken from the logs.

CPUE and effort - The average CPUE corresponds to the ratio of total landings (y_i) to the number of trap hauled (tf_i) reported in the logs: $CPUE = \sum y_i / \sum tf_i$. The total effort (total number of trap hauls: F) was then estimated from total landings (Y) divided by average CPUE: $F = Y / CPUE$. The geographic distribution of fishing effort was presented as a sum of number of trap hauls within each 10' latitude by 10' longitude grid. The fishing positions were taken from the logs. The geographic distribution of average CPUE was calculated within each of these grids.

Industry data

Since 1998, one of the snow crab buyer/processor of Area 4X has been sending in, on a regular and voluntary basis, reports on the landings of each of the 4X vessel doing business with his plant. Each report includes; the date landed, the dockside weight, the dockside weight subdivided into categories (dead, mossy/cull, 0-400 g, 400-500 g, 500-600 g, 600-700 g, and 700 g+), the quality of the catch, the type of gear used, and sometime detailed positions of all fishing location visited by this vessel. Often, these reports come with comments on the type of baits used, the presence of females, etc... These reports covered three vessels in 1998 and two in 1999.

This industry originating data have been compiled, and the weight of each category transformed into percentage ratios based on the total dockside landing reported for each of

the two given years. This industry classification of the 1998 and 1999 landings (as percentage ratios based on weight) is graphically presented, for each year, for the following categories: culls/dead, 0-500 g, 500-600 g, 600-700 g, and 700 g+.

Trap survey

An exploratory trap survey was conducted in 1999 which covered 63 grids of 10' latitude by 10' longitude (Fig. 2). The area to be surveyed was divided into 4 bloc of 15-16 grids, and each of the four fishermen was responsible to realize the survey in his designated blocks. The blocks of grids were to be surveyed consecutively. The central points of each grid were given as a reference point, and fishermen were requested to place three (6' diameter) or 5 (4' diameter) traps on a single line within each grid of the allocated block. Each set of traps required that a temperature probe be attached to one of the traps. These traps were to be fished 24 to 48 hours later with a DFO-Science biologist on board for the biological sampling.

Trap sampling – For each trap, the total number of male crabs, the position and the depth were recorded, and the following measurements were taken for all snow crab captured: the carapace width (CW), the height of the right claw (CH), the condition of the carapace (on a scale of 1 to 5) and the hardness of the right claw measured with a durometer (Floyle *et al.* 1989), for the males; CW, the width of the fifth abdominal segment (AW) and the color of the eggs, for the females. Snow crab with a claw hardness less then 68 in durometer reading were considered as soft-shell crab (Hébert *et al.* 1992).

Morphological maturity – The present document use the terminology of "adolescent" (small claw) for non-terminal molt males and "adult" (large claw) to represent the terminal molt males (Sainte-Marie *et al.* 1995). Adults males are recognizable by morphometry by plotting logarithms of chela height (CH) against logarithms of carapace width (CW) (Conan and Comeau, 1986). Data from adult and adolescent crab fit into two distinct ellipses with parallel major axes (Conan and Comeau, 1986). Until the necessity for a specific discriminant function is required, and a morphological study realized, the following discriminant function developed for the eastern Nova Scotia fisheries in 1998 (Biron *et al.* 1999) will be used;

$$Y = 19.775707 \ln (CH) - 25.324040 \ln (CW) + 56.649941,$$

which assign individuals to the correct groups in 99% of cases (for adult males: $Y > 0$).

Carapace condition - Crabs were categorized into five groups based on the carapace condition and hardness (Anonymous 1994). Classification of carapace stages based on carapace condition, durometer reading and corresponding approximate age after terminal molt is presented in Appendix 1. Crabs identified as carapace condition 1 or "New soft", and carapace condition 2 or "Clean" with durometer reading less than 68 were considered as postmolt soft-shell crab.

RESULTS

Fishery

1994

Fishing effort distribution – The fishing effort and area covered in 1994 were very limited (Fig. 3).

Landings - Total landings in 1994 was 130 kg. (Table 1). Landings were reported between September 13 and September 26, 1994, although one fisherman reported landings snow crab prior to the opening of this fishery, on June 16, 1994 (Table 2; Figs. 4 and 5).

CPUE and effort - The average CPUE was 1.6 kg/th in 1994, while total effort was estimated at 82 trap hauls in (Figs. 6 and 7).

1995

Fishing effort distribution – A lot of fishing grounds were explored in 1995 and fishermen tried to cover most of the potential crab habitat in 4X(Fig. 8).

Landings - Total landings in 1995 were 18t (Table 1). The landings occurred from March 4 to September 29, 1995 (Table 2; Figs. 4 and 5).

CPUE and effort - The seasonal CPUE was estimated at 1.5 kg/trap haul, ranging between 0.01 to 4.3 kg/trap haul throughout the fishing season (Figs. 6 and 7). The fishing effort (12,528 trap hauls) was the highest recorded to date for this fishery (Figs. 6 and 7).

1996

Fishing effort distribution – Fishing locations in 1996 show that fishermen concentrated their fishing effort predominantly around the major banks of 4X, such as Brown, Baccaro and Roseway (Fig. 9).

Landings - Total landings in 1996 (11t)(Table 1) were 40% lower than those reported in 1995 (Table 2; Figs. 4 and 5). Fishing occurred from March 26 to September 6, 1996.

CPUE and effort - The average seasonal CPUE was 1.0 kg/th (Figs. 6 and 7). Total effort in 1996 (10,935 trap hauls) was 15% lower than 1995 (Figs. 6 and 7).

1997

Fishing effort distribution - Only one fisherman fished for snow crab in 1997, and his fishing locations based on logbooks received show that his fishing activity was concentrated in the Roseway Basin (Fig. 10).

Landings – Total landings in 1997 were 2t (Table 1), and the fishing activities began on April 4, 1997 and was over one month later, on May 8, 1997 (Table 2; Figs. 4 and 5).

CPUE and effort - The average seasonal catch rate was estimated at 2.3 kg/th, while the total seasonal effort was 700 trap hauls in 1997 (Figs. 6 and 7).

1998

Fishing effort distribution – This exploratory fishery has encountered a higher concentration of crabs in 1998 compared to any previous year. This increase in CPUE is solely due to the higher density concentration of snow crab found along the NAFO fishery boundary 4X/4W (referred as the Lunenburg – Halifax area in the present document), and the resulting concentration of fishing effort by three of the four fishermen. The usual exploratory activity since this fishery started in 1994 has been predominantly around the major banks of 4X, such as Brown, Baccaro and Roseway (Fig. 11).

Landings – Total landings in 1998 were 42t (Table 1). Landings occurred mainly during the first half of the year, from February 3 to June 23 and from November 5th to December 20 (Table 2; Figs. 4 and 5).

CPUE and effort - The seasonal CPUE was 5.4 kg/trap haul, which represent a 55 to 80% increase compared to previous years, while the total effort decreased by 25 and 35% (7,900 trap hauls) compared to 1996 and 1995, respectively (Figs. 6 and 7).

1999

Fishing effort distribution – The pattern of fishing effort distribution in 1999 was similar to 1998, with 3 fishermen concentrating their effort along the NAFO fishery boundary 4X/4W, while the fourth one remained around the Roseway Basin (Fig. 12).

Landings - Total landings in 1999 were estimated at 91t (Table 1), representing a 215% increase compared to 1998, and are the highest landing to date for this exploratory fishery (Table 2; Figs. 4 and 5). Again, landings occurred mainly during the first half of the year, from January 1 to August 22, 1999.

CPUE and effort - The seasonal CPUE of 11.4 kg/trap haul is the highest value ever recorded since 1994 (Figs. 6 and 7). The total effort was 8,003 trap hauls, which represent a similar fishing effort compared to 1998 (Figs. 6 and 7).

Industry data

The 1998 data regroups landings from three vessels, which added up to 63,800 lbs (28,940 kg), while the 1999 data regroups landings from two vessels which totalized 44,000 lbs (19,960 kg)(Fig. 13). There was no weighted data concerning the culls/dead category in

1998, and the percentage shown for that year is based on the seasonal estimation of 10-12% presented in the final 1998 industry report.

Trap survey

A total of 63 grids of 10' latitude by 10' longitude were successfully sampled during the 1999 trap survey.

Block #1

The 16 sets of 5 traps (4' conical) that made up the first block of grids sampled were set near the center of each grid (Fig. 2). Traps were hauled approximately 40 hours after being set. A total of 15 adult male snow crab were caught with 16 sets of traps (80 traps total) and measured.

Once the work for this survey was completed, 2 sets (i.e. 2 single lines) of 25 traps (4' conical), and 1 set of 20 traps that have been set 4 days earlier on the usual fishing grounds, were fished. For each of these three sets, and before sorting, sub-samples of snow crab were randomly taken (i.e. as the traps were fished one after the other, the entire content of the traps were emptied into a fish box until judged full. In total, 88 adult male snow crabs were measured using the same method used for the survey. There was no female or adolescent male present in the sub-sample and no female was observed in the entire catch.

The average size of the combined data (15 crabs from survey + 88 crabs from commercial fishery) was 104.9 mm, with over 60 percent of the adult male being larger than 102 mm CW (Tables 3 and 4; Fig. 14). The majority of the crabs were of carapace condition 4 (52.0%) and 3 (39.2%)(Fig. 15). Temperature data collected is presented in Figure 16.

Block #2

Fifteen sets of 3 traps (6' conical fished individually) made up the second block of grids (Fig. 2). They were set on July 7 and 8. Traps were hauled approximately 40 to 45 hours after being set. A total of 156 male and 3 female snow crabs was caught. The first trap of the second set of trap sampled that day contained 125 crab, and at that time it was decided to take a random sub-sample of 40 males and all 3 females. It was the only trap with more than 5 snow crabs and also one of the only seven traps to have snow crab in it. Therefore, only 54 adult males out of the 156 captured during the survey were measured.

The average size was 100.8 mm, with 32% percent of the adult male being smaller than 95 mm CW (Tables 3 and 4; Fig. 14). The majority of the crabs were of carapace condition 3 (50%)(Fig. 15). No temperature data was collected for this block.

Block #3

Sixteen sets of 5 traps (4' conical) made up the third block of grids sampled and were set on September 27 (Fig. 2). Traps were hauled approximately 45 hours after being set. A total of 175 male snow crabs were caught in this bloc of the survey and all 175 were found in the 5 traps of the first set fished. The crab found in the first 3 traps (N=74) were used as a sub-sample for the set.

The average size was 94.1 mm, with almost 50% percent of the adult male being smaller than 95 mm CW (Tables 3 and 4; Fig. 14). The majority of the crabs were of carapace condition 3 (67.6%)(Fig. 15). Temperature data collected is presented in Figure 16.

Block #4

Sixteen sets of 5 traps (4' conical) made up the forth block of grids sampled and were set on October 13 (Fig. 2). Traps were hauled approximately 45 hours after being set. Traps were hauled approximately 40 to 45 hours after being set. Only 1 adult male snow crab (CW 98.5 mm) was caught in this bloc of the survey. Temperature data collected is presented in Figure 16.

DISCUSSION

The 1999 total landings in southwestern Nova Scotia were almost 215% higher than those of 1998. There was a 53% increase in the seasonal CPUE and a similar level of total fishing effort compared to 1998. This exploratory fishery has encountered a higher concentration of crab in 1998 and 1999 compared to the period of 1994-97. Although the recent seasonal catch rate of 5.4 and 11.4 kg/trap haul is considerably higher than the historical catch rate of 1-2 kg/trap, it is still 5 to10 times lower than the seasonal value found in eastern Nova Scotia during the same years. This increase in CPUE is solely due to the higher density concentration of snow crab found along the NAFO fishery boundary 4X/4W, and the resulting concentration of fishing effort by three of the four fishermen.

Fishing Patterns

The identification of a higher than usual concentration of crabs in the Lunenburg – Halifax area in 1998-99, prompted a review of the fishing location found on the historical logbooks (1994 to date). From 1994 to 1997, the usual fishing locations have been mainly located southwest of LaHave Basin, and along the Northeast Channel. In 1998, most of the effort was concentrated near shore in the Lunenburg – Halifax area to the point where limits surrounding this area were drawn, and special measures restricting effort were imposed. The remaining effort in 1998 was limited to the Roseway Basin area. The distribution of effort in 1999 was similar to 1998 with one fisherman fishing the Roseway Basin, while the other three fished the Lunenburg – Halifax area. However, in the Lunenburg – Halifax area, fishermen which started the year by fishing the restricted area, found low catch rates and

moved to the adjacent westerly and southerly grounds. It was on these grounds outside of the restricted box that most of the effort and catches occurred in 1999.

Catch rates and effort

Catch rates have increased progressively from the initial low rates of 2 kg/th experienced at the beginning of this exploratory fishery (1994–1997), to 5.4 kg/th in 1998 and 11.4 kg/th in 1999. In contrast, the total seasonal effort has steadily decreased from 12,500 trap hauls in 1995 to 8,000 in 1998 and 1999. The 1998 and 1999 fishery data showed a seasonal pattern in CPUE fluctuation in the current exploratory fishery, with the highest rates observed in the January-April period (winter).

In 1995, one fisherman has fished the Lunenburg – Halifax area, the same area where a high concentration of crab was found in 1998-99, but the CPUE was less than 2 kg/th that year.

Distribution of snow crab in 4X

According to Tremblay and Eagles (1996), snow crab on the Scotian Shelf are found mainly where summer bottom temperatures are less than 3°C. These conditions are limited to the eastern Scotian Shelf and cold pockets off southwestern Nova Scotia. Describing the prospect for the 4X snow crab fishery in the 1995 stock assessment document, they considered that while commercial catch rates on the western Scotian Shelf may improve with fishing skill, the snow crab aggregations west of Sable Island Bank are likely ephemeral. An historical review of the groundfish survey on the Scotian Shelf revealed that of a total of 5,801 trawl sets between 1980 and 1994, 96 (1.7%) yielded snow crab (Tremblay et al. 1994). There were only three positive sets west of 62° longitude.

The trap survey supports the ephemeral distribution of snow crab by finding that crabs are absent of most of the fishing grounds in 4X. A probable cause is the warm bottom temperature. Most of the grids surveyed, especially in blocks 3 and 4, had averaged temperature above 7°C and no snow crab was present. However, all the snow crab captured during the survey in blocks 1, 3 and 4, were caught in water warmer than 3°C. The set of trap that captured the highest number of snow crab (block 3, set 1; 175 crabs) had a bottom temperature that ranged between 4 and 5°C. Another noticeable exception was in bloc 1 where most of the crabs were caught in water ranging between 5 and 7°C. It might be that snow crab, when forced, may develop a certain tolerance to slightly warmer water to survive, but have to find colder water to thrive?

The grids with the coldest bottom temperature (3 – 5°C) were usually the inshore ones. The coldest temperature (3°C) was recorded at 46 fathoms, on hard bottom close to shore. The warmest temperatures were found on the banks and offshore. Based on the historical logbooks and the trap survey data, it is our beliefs that the snow crab habitat in 4X is presently limited to the Roseway Basin area and the inshore area currently exploited by three of the four fishermen (known as the Lunenburg – Halifax area). The offshore area

(including all the banks) seems to be Jonah crab or Northern Stone crab habitat; these two species were commonly found in the survey traps when snow crab was absent.

Population structure

The catch composition established from the trap survey samples in 1999 shows a low rate of adolescent males entering the traps (3.9%). The Roseway Basin area had the highest concentration of large adult crabs (60% > 102 mm), while the lowest rate was found in the Lunenburg – Halifax area (32 - 49% < 95 mm). The majority of the crabs captured during the survey were of carapace condition 3 (51%) and 4 (34%). However, one fisherman has recently reported finding a small hole that had mostly white crab. In other words, the trap survey described here has covered very little grounds and the total number of crab sampled (N=231) may not properly represent the true picture of the snow crab population structure of Area 4X.

Only three females were observed during the survey and all were caught in the same trap. They were multiparous females carrying new clutches of eggs. An interesting comment in one of the Industry Reports mention that females with eggs are not observed during the winter months of the fishery: ovigerous females are usually first-sighted towards the end of March. This may indicate an irregular reproductive activity or abnormal reproductive condition.

The majority of the recruitment to this fishery is likely to originate from the eastern Scotian Shelf or the southern Gulf of St. Lawrence (Tremblay and Eagles, 1996), with most of the recruitment arriving at the larval stage and free floating. Davidson et al. (1985) reported no difference between eastern and western Cape Breton stocks and suggested that genetic homogeneity was maintained by larval transport. Since the larval period is about 3 months, and given currents in the region, larvae hatching on the Gulf side of Cape Breton eventually settle in eastern Nova Scotia (Davidson et al. 1985). Given the unidirectional surface current flowing east – west on the Scotian Shelf (Hannah et al. 2000), a substantial number of larvae hatched off eastern Nova Scotia must be transported towards 4X. The distribution of advanced stages of snow crab larvae on the Scotian Shelf also suggested that larvae are transported southerly from eastern Cape Breton (Roff et al. 1986; Tremblay et al. 1994).

CONCLUSIONS, RECOMMENDATIONS AND OUTLOOK

Based on the historical fishing trend and the trap survey results in this exploratory (NAFO Division 4X) snow crab fishery, the following factors suggest the necessity of a cautious approach for making management decision whether this fishery can be a permanent fishery with a limited number of vessels:

1. There are uncertainties in the current assessment of the resource status:

i) The available snow crab biomass for this Area is unknown, and there is no scientifically justifiable data to determinate a TAC limit;

ii) The biological basis for determining the current resource status is restricted to landings (0-20% DMP) and catch rates, together with the 1998-99 industry sampling of commercial catch size frequencies and the 1999 trap survey with its small sample size (N=231);

iii) Our longest time series is for the Roseway Basin area (1994-99) which has remained more or less constant since the beginning, and does not represent the sudden increase in landings witnessed in the Lunenburg – Halifax area in 1998-99.

2. Exploratory Area 4X is the southern most limit for the natural distribution of snow crab. Therefore, snow crab habitat is limited to small areas of 'colder' summer bottom temperature (4-7°C) with its current commercial grounds probably being now exploited. The simple fact of being at the limit of the natural range, this fishery would be more susceptible to sudden environmental changes.

3. There will be a need from Science to collect better fishery and biological data to properly assess the resource, if this exploratory fishery is to become permanent. There is no strong sign of the existance of breeding parental population (e.g. females were merely caught), and there was anectodal information of the occurence of non-ovigerous females. Standard fishery monitoring requirement now in use in eastern Nova Scotia fisheries should be applied (i.e., 100% dockside monitoring, a minimum observer program coverage, a defined season, etc...).

4. Based on the current available information on the biological and fishery status of this fishery, this southern most fishery grounds should be considered as a sporadic fishery where commercial size males migrate from the northern Scotian Shelf when the biomass is at high levels. The quantity of migrating biomass has not been assessed so far and may considerably vary from year to year. Especially a change of the exploitation regime in the northern fisheries on the Scotian Shelf (Areas 20 to 24) together with water temperature fluctuation.

REFERENCES

Anonymous. 1994. General overview of Atlantic coast snow crab and report on the status of snow crab in the southern Gulf of St. Lawrence (Fishing areas 12,18,19 25 and 26). DFO Atlantic Fisheries Stock Status Rep. 94/1.

Biron, M., M. Moriyasu, E. Wade, P. DeGrâce, R. Campbell and M. Hébert. 1999. Assessment of the 1997 Snow crab (*Chionoecetes opilio)* fishery off eastern Cape Breton, Nova Scotia (CFAs 20 to 24, and 4X). Can. Stock Assess. Sec. Res. Doc., 99/12

CAFSAC, 1991. CAFSAC Invertebrates and Marine Plants Subcommittee Meeting of 26-28 November, 1991, St. John's NFLD. CAFSAC Invertebrates and Marine Plants Subcommittee report. 91/19.

Conan , G.Y. and M. Comeau. 1986. Functional maturity of male snow crab, (Chionoecetes opilio). Can. J. Fish. Aquat. Sci. 43 : 1710-1719.

Davidson, K., J.C. Roff and R.W. Elner. 1985. Morphological, electrophoretic, and fecundity characteristics of Atlantic snow crab, *Chionoecetes opilio*, and implications for fisheries management. Can. J. Fish. Aquat. Sci. 42(3): 474-482.

Foyle, T.P., G.V. Hurley, and D.M. Taylor. 1989. Field testing shell hardness guages for the snow crab fishery. Can. Ind. Rep. Fish. Aquat. Sci. 193.

Hannah, C.G., J.A. Shore, J.W. Loder and C.E. Naimie. 2000. Seasonal circulation on the western and central Scotian Shelf. J. Phys. Oceannogr. (in press)

Hébert, M., C. Gallant, Y. Chiasson, P. Mallet, P. DeGrâce, et M. Moriyasu. 1992. Le suivi du pourcentage de crabes mous dans les prises commerciales de crabe des neiges (Chionoecetes opilio) dans le sud-ouest du golfe du Saint-Laurent (zone 12) en 1990 et 1991. Rapp. Tech. Can. Sci. Halieut. Aquat. 1886.

Roff, J.C., L.P. Fanning, and A.B. Stasko. 1986. Distribution of larval crabs (Decapoda: Brachyura) on the Scotia Shelf. Can. J. Fish. Aquat. Sci. 43:587-599.

Sainte-Marie, B., S. Raymond and J.-C. Brêthes. 1995. Growth and maturation of the benthic stages of male snow crab, Chionoecetes opilio (Brachyura: Majidae). Can. J. Fish. Aqua. Sci. 52: 903-924.

Squires, H.J. 1990. Decapod Crustacea of the Atlantic Coast of Canada. Can. Bull. Fish. Aquat. Sci. 221: 532p.

Tremblay, M.J. 1997. Snow crab (*Chionoecetes opilio*) Distribution limits and Abundance trends on the Scotian Shelf. J. Northw. Atl. Fish. Sci., 21:7-22.

Tremblay, M.J. and M.D. Eagles. 1996. Assessment of the 1995 snow crab fishery off eastern Nova Scotia. DFO Atlantic Fish. Res. Doc. 96/xx.

Tremblay, M.J., M.D. Eagles and R.W. Elner. 1994. Catch, effort and population structure in the snow crab fishery off eastern Cape Breton, 1978-1993: a retrospective. Can. Tech. Rep. Fish. Aquat. Sci. 2021.

Table 1. Landings of snow crab (*Chionoecetes opilio)* for southwestern Nova Scotia (Exploratory NAFO Area 4X), 1994 - 1999.

Year	Active licenses/permits	Landing Statistics (t)	Total mean CPUE (kg/trap haul)	Total Effort (trap hauls)
1994	4	0.1	1.58	82
1995	4	18	1.46	12,528
1996	4	11	1.02	10,717
1997	1	2	2.27	700
1998	4	42	5.35	7,893
1999	4	91	11.41	8,003
Average (all)		27.4	3.85	6654

Table 2. Weekly landings, CPUE and fishing effort in 4X, from 1994 to 1999.

	landings (kg)						effort						CPUE (kg/th)					
week	1994	1995	1996	1997	1998	1999	1994	1995	1996	1997	1998	1999	1994	1995	1996	1997	1998	1999
(Jan.) 1						3275												
2						1110												
3						2723												
4						2135						90						7.68
5						1923						116					4.55	16.58
(Feb.) 6					1713	4806					645	206					4.35	21.38
7					1366	5341					385	218					5.57	24.50
8					3668	5584					820	227					10.47	24.60
9		0.5			3569	4253		46			568	425		0.01			8.84	10.01
(March)10		3			7642	160		163			1540	11		0.02			13.58	14.55
11		641			2172	3227		310			160	412		2.07			9.82	7.83
12		1303			3596	4937		300			450	706		4.34			7.16	6.60
13		1089	1535		5442	3835		442	999		760	329		2.46	1.54		6.50	11.66
(April) 14		1027	2316		2504	5500		344	748		380	648		2.99	3.10			8.49
15		666	899	343	475	3348		344	439	100		499		1.94	2.05	3.43		6.71
16		2093	444	565	938	3228		719	479	100		200		2.91	0.93	5.65		16.14
17		753	117	441	1945	1814		454	247	200		30		1.66	0.47	2.21		60.47
18		633	264	135	2493	2395		568	496	200		60		1.11	0.53	0.68		39.92
(May) 19		278	1710		1247	1325		278	824			30		1.00	2.08			44.17
20		1126		108	953	1469		669		100		30		1.68		1.08		48.97
21		512			953			300						1.71				
22		338			763			278						1.22				
(June) 23		516				713		345				149		1.50				4.79
24	45	210			606	763	17	330			125	323	2.67	0.64				2.36
25		461	126			288		360	210			150		1.28	0.60			1.92
26		688	123		201	190		445	500		125	150		1.55	0.25			1.27
(July) 27		1403	752					605	1000					2.32	0.75			
28		1048	204			838		751	250			89		1.40	0.82			9.42
29		696	100			2181		467	250			70		1.49	0.40			31.16
30		634	367			1230		706	750			40		0.90	0.49			30.75
31		903	491					856	750					1.06	0.65			
(Aug.) 32		496	582					726	1000					0.68	0.58			
33		240	366			486		265	750			35		0.91	0.49			13.89
34		99	232					178	250					0.56	0.93			
35		111	250					350	525					0.32	0.48			
(Sept.) 36		121	57					348	250					0.35	0.23			
37	84	73					50	174					1.69	0.42				
38		71						174						0.41				
39	0	46					15	233					0	0.20				
(Oct.) 40																		
total*	130	18281	10935	1592	42246	91356	82	12528	10717	700	7893	8003	1.58	1.46	1.02	2.27	5.35	11.41

*Total seasonal landings

Table 3. Catch composition (in percentage) from the trap survey samples.

a) Catch composition in percentage of Block 1.

Size	Hard shell crab		Soft shell crab		By maturity stage		Total
	small claw	large claw	small claw	large claw	small claw	large claw	
< 95 mm	0	18.4	0	0	0	18.4	18.4
95 – 102 mm	0	21.4	0	0	0	21.4	21.4
> 102 mm	0	58.3	0	1.9	0	60.2	60.2
total	0	98.1	0	1.9	0	100.0	100.0

b) Catch composition in percentage of Block 2.

Size	Hard shell crab		Soft shell crab		By maturity stage		Total
	small claw	large claw	small claw	large claw	small claw	large claw	
< 95 mm	0	29.6	0	1.9	0	31.5	31.5
95 – 102 mm	0	20.4	3.7	0	3.7	20.4	24.1
> 102 mm	1.9	40.7	1.9	0	3.7	40.7	44.4
total	1.9	90.7	5.6	1.9	7.4	92.6	100.0

c) Catch composition in percentage of Block 3.

Size	Hard shell crab		Soft shell crab		By maturity stage		Total
	small claw	large claw	small claw	large claw	small claw	large claw	
< 95 mm	2.7	41.9	4.1	0	6.7	41.9	48.6
95 – 102 mm	1.4	35.1	0	0	1.4	35.1	36.5
> 102 mm	0	14.9	0	0	0	14.9	14.9
total	4.1	91.9	4.1	0	8.1	91.9	100.0

d) Catch composition in percentage of Blocks 1, 2 and 3.

Size	Hard shell crab		Soft shell crab		By maturity stage		Total
	small claw	large claw	small claw	large claw	small claw	large claw	
< 95 mm	0.9	28.6	1.3	0.4	2.2	29.0	31.2
95 – 102 mm	0.4	25.5	0.9	0	1.3	25.5	26.8
> 102 mm	0.4	40.3	0.4	0.9	0.9	41.1	42.0
total	1.7	94.4	2.6	1.3	4.3	95.7	100.0

Table 4. Catch composition (in number) from the trap survey samples.

a) Catch composition in number of Bloc 1.

Size	Hard shell crab		Soft shell crab		By maturity stage		Total
	small claw	large claw	small claw	large claw	small claw	large claw	
< 95 mm	0	19	0	0	0	19	19
95 – 102 mm	0	22	0	0	0	22	22
> 102 mm	0	60	0	2	0	62	62
total	0	101	0	2	0	103	103

b) Catch composition in number of Bloc 2.

Size	Hard shell crab		Soft shell crab		By maturity stage		Total
	small claw	large claw	small claw	large claw	small claw	large claw	
< 95 mm	0	16	0	1	0	17	17
95 – 102 mm	0	11	2	0	2	11	13
> 102 mm	1	22	1	0	2	22	24
total	1	49	3	1	4	50	54

c) Catch composition in number of Bloc 3.

Size	Hard shell crab		Soft shell crab		By maturity stage		Total
	small claw	large claw	small claw	large claw	small claw	large claw	
< 95 mm	2	31	3	0	5	31	36
95 – 102 mm	1	26	0	0	1	26	27
> 102 mm	0	11	0	0	0	11	11
total	3	68	3	0	6	68	74

d) Catch composition in number of Bloc 1, 2 and 3.

Size	Hard shell crab		Soft shell crab		By maturity stage		Total
	small claw	large claw	small claw	large claw	small claw	large claw	
< 95 mm	2	66	3	1	5	67	72
95 – 102 mm	1	59	2	0	3	59	62
> 102 mm	1	93	1	2	2	95	97
total	4	218	6	3	10	221	231

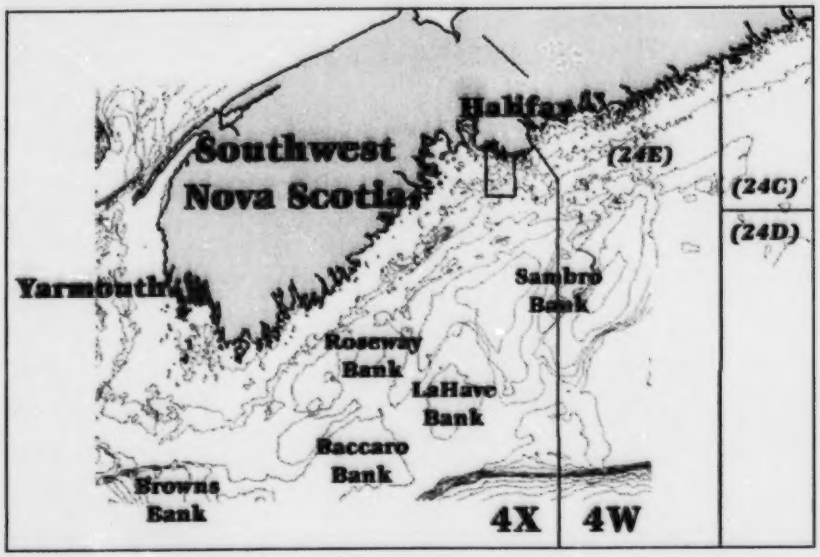


Figure 1. Snow crab Area 4X (CFA-27) off southern Nova Scotia.

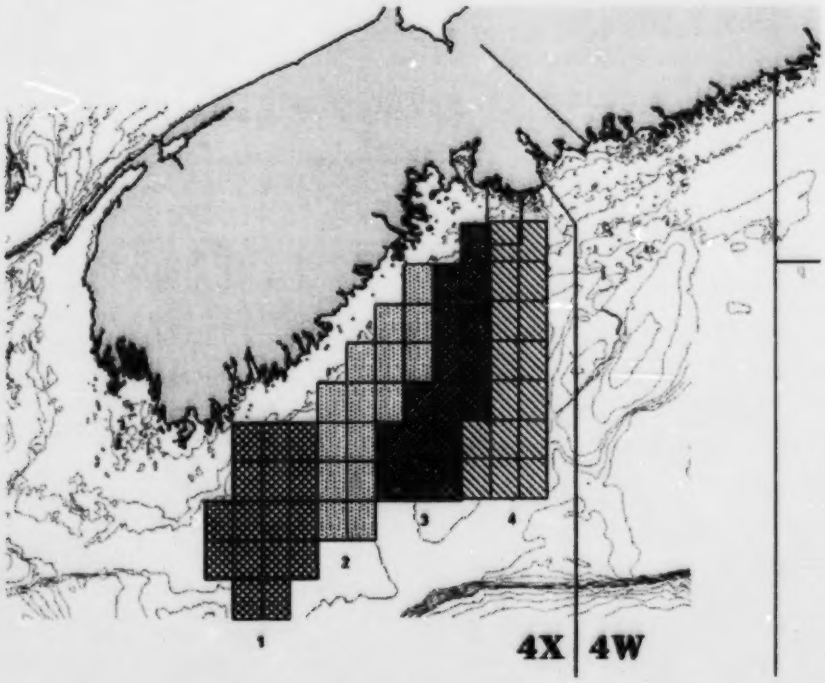


Figure 2. The 63 grids of 10' latitude by 10' longitude (four blocks of 15 to 16 grids each) surveyed in 1999.

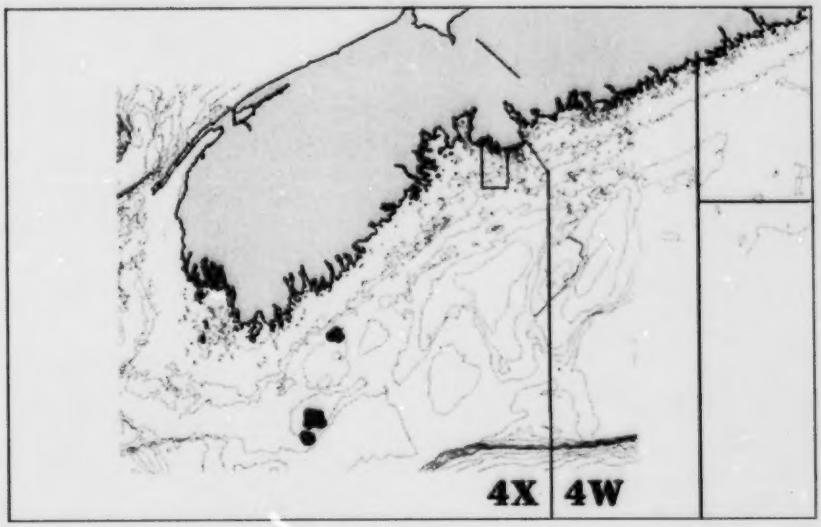


Figure 3. Reported logbook positions in 1994.

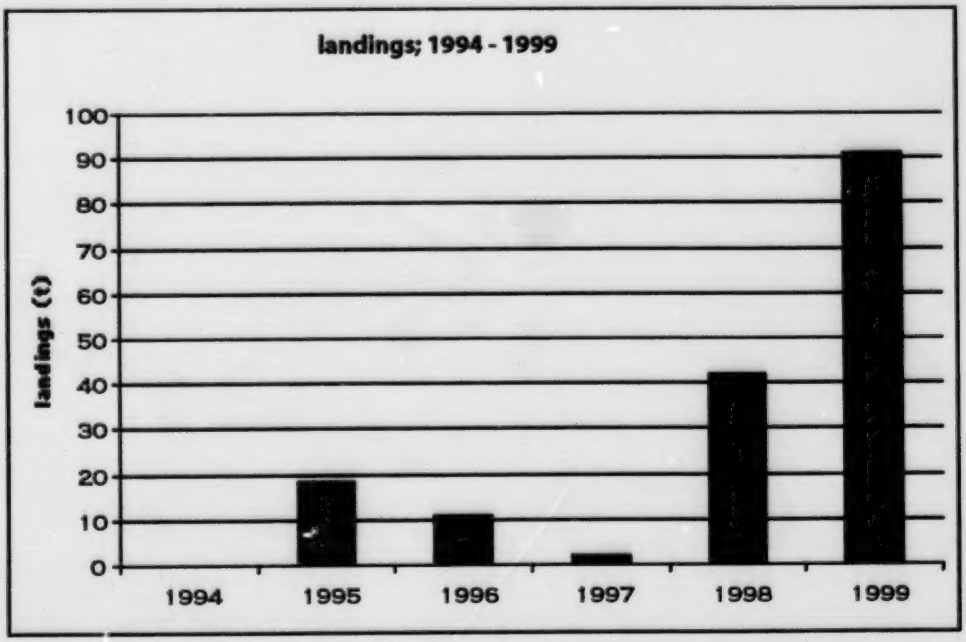


Figure 4. Snow crab landings (t) in SWNS from 1994 to 1999.

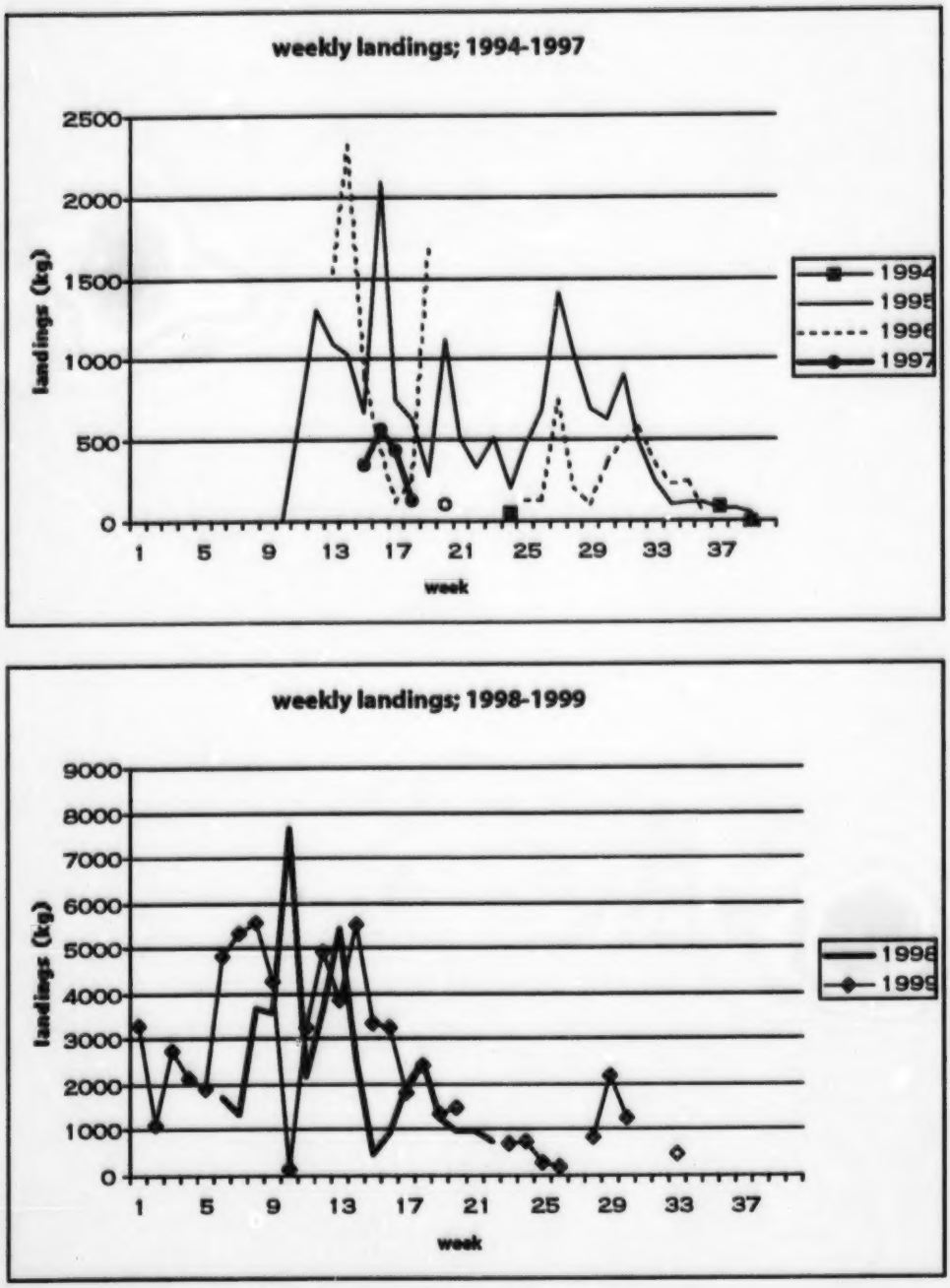


Figure 5. Weekly landings of snow crab in SWNS, from 1994 – 1999.

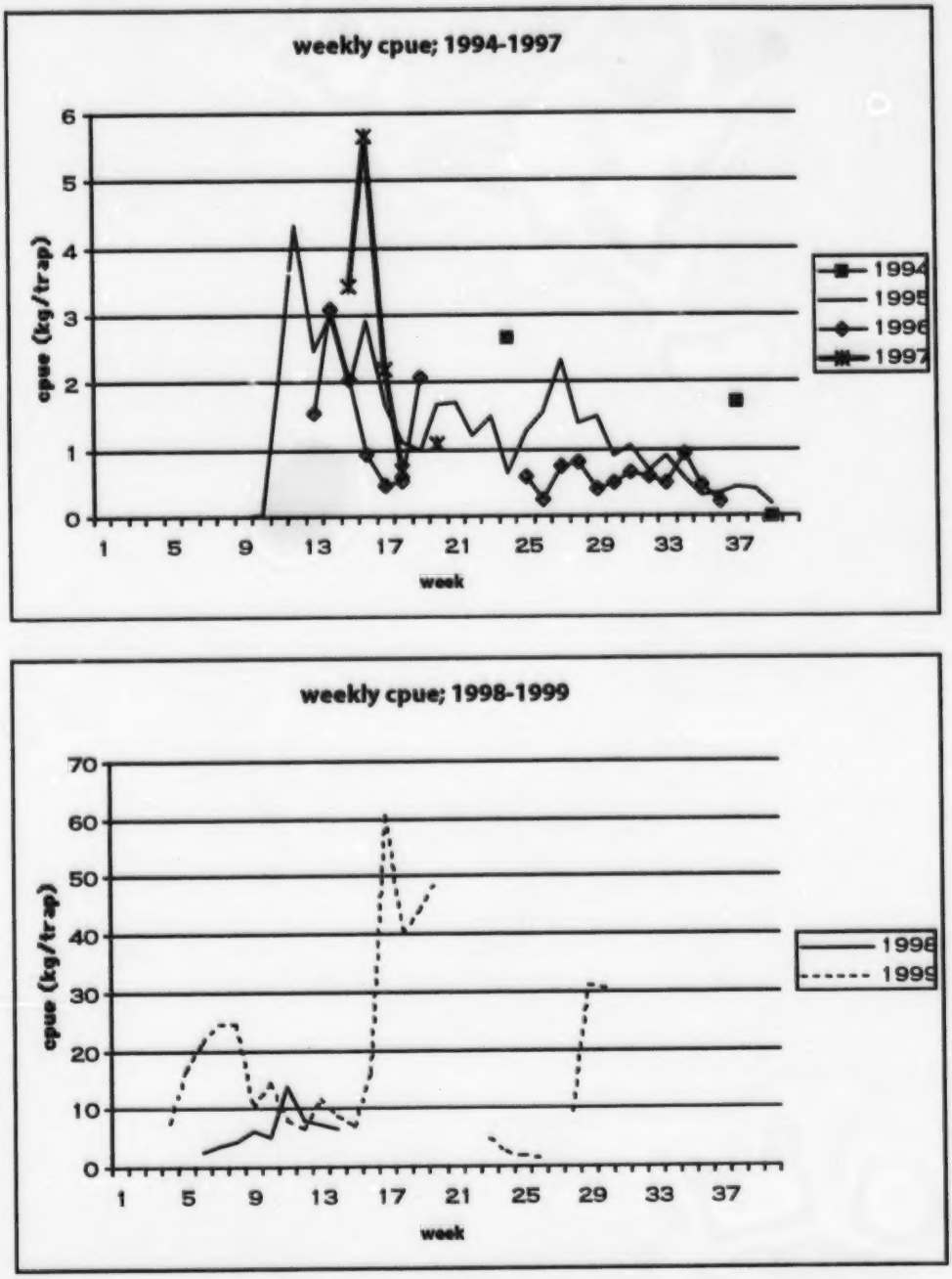
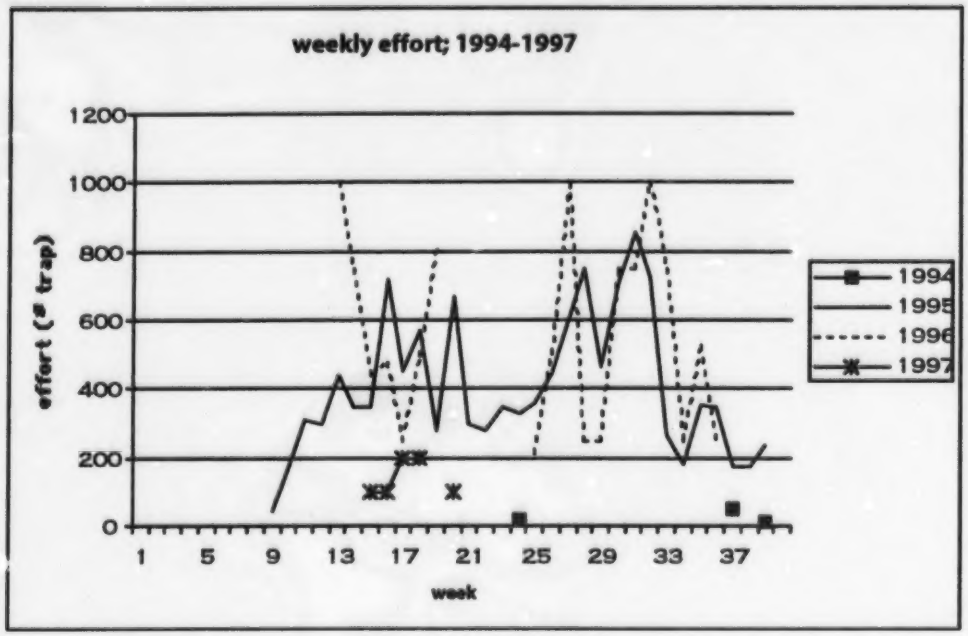


Figure 6. Weekly CPUE in SWNS, from 1994 to 1999.



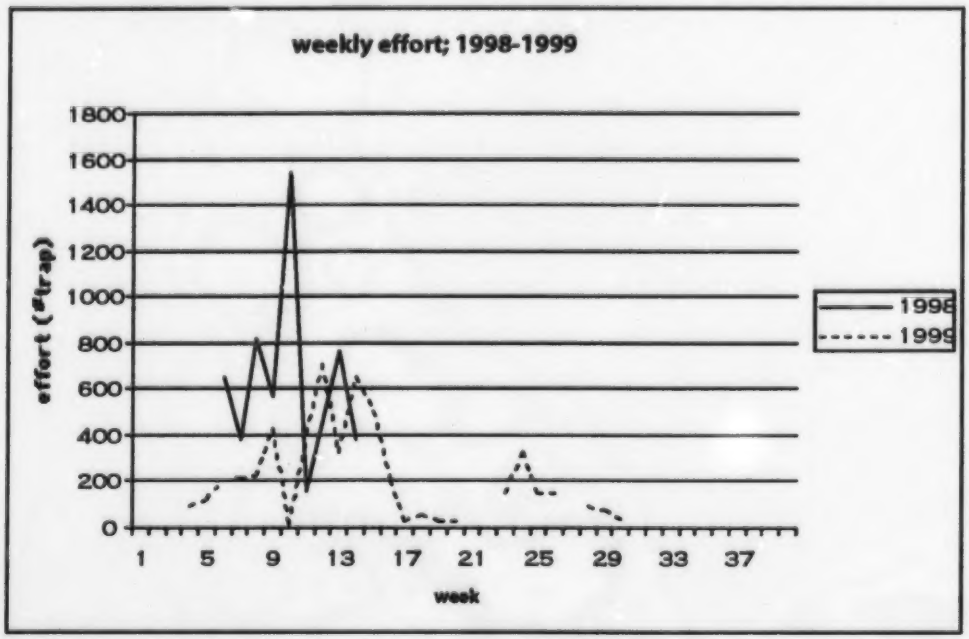


Figure 7. Weekly effort in SWNS, from 1994 to 1999.

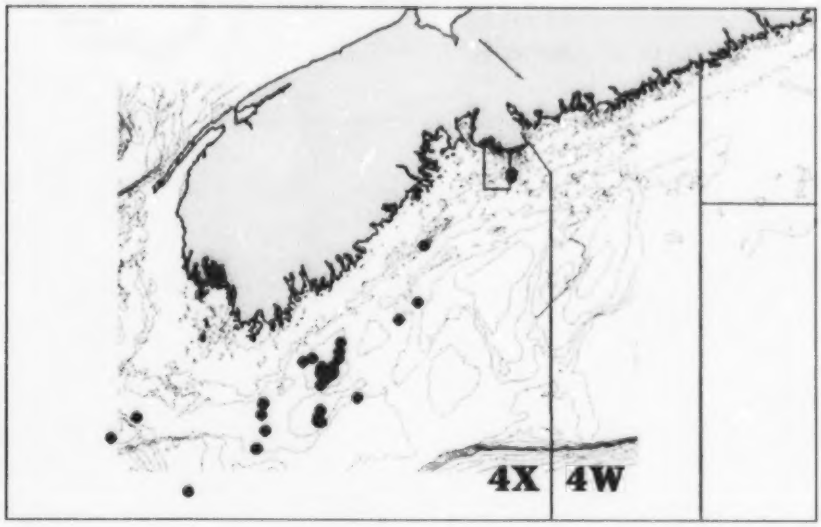


Figure 8. Reportcd logbook positions in 1995.

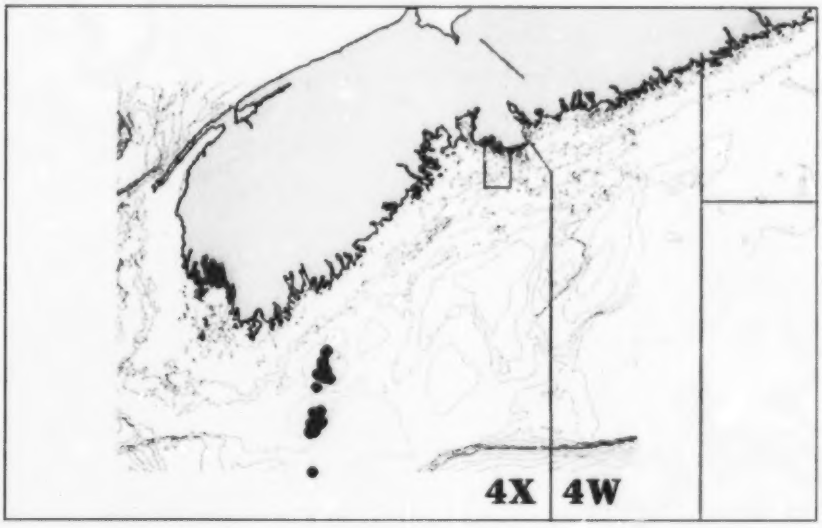


Figure 9. Reported logbook positions in 1996.

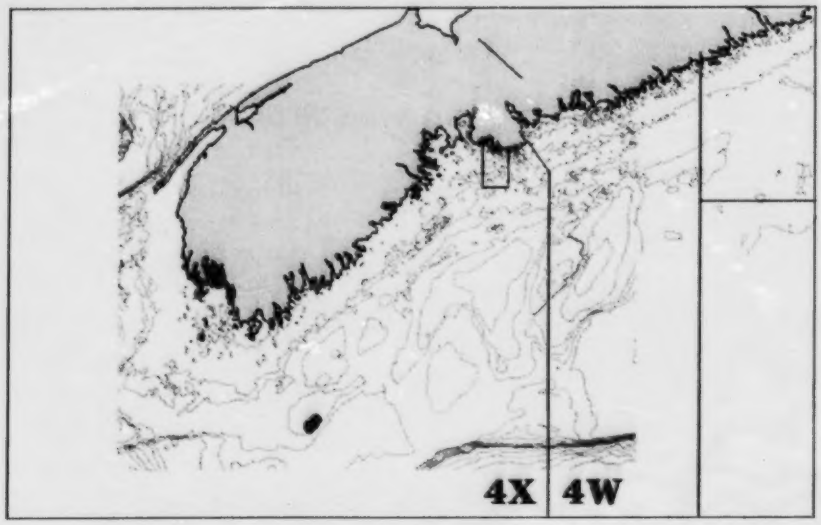


Figure 10. Reported logbook positions in 1997.

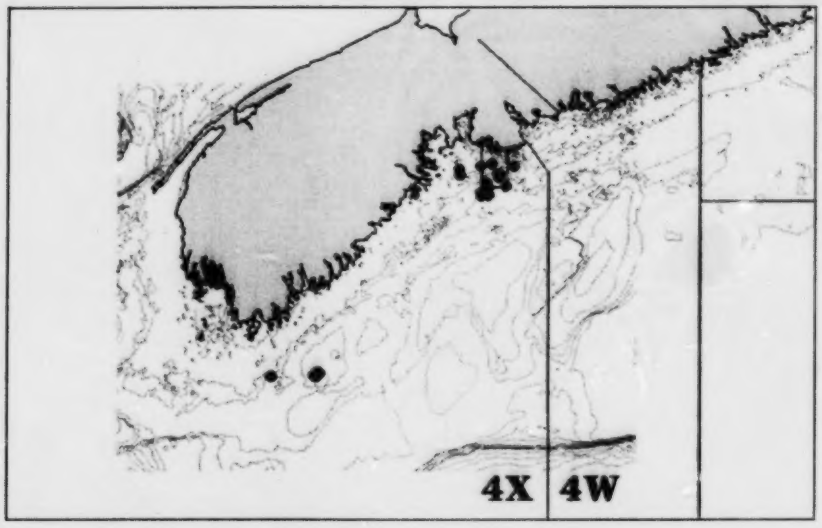


Figure 11. Reported logbook positions in 1998.

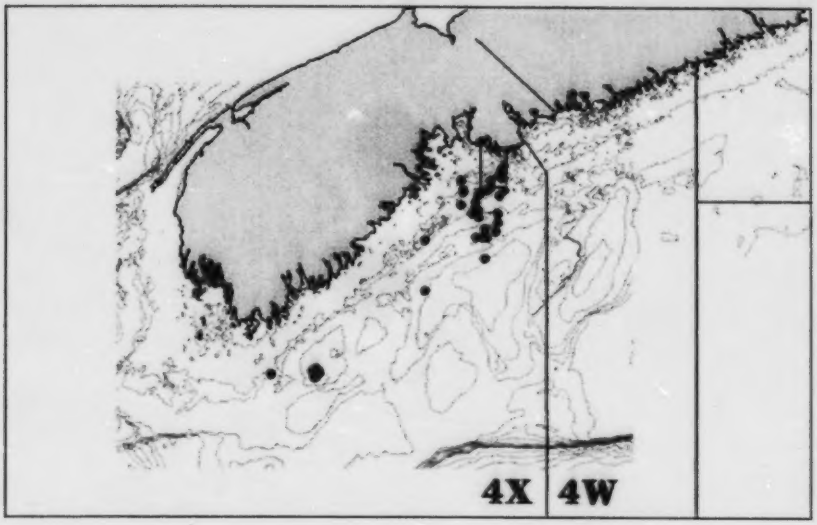
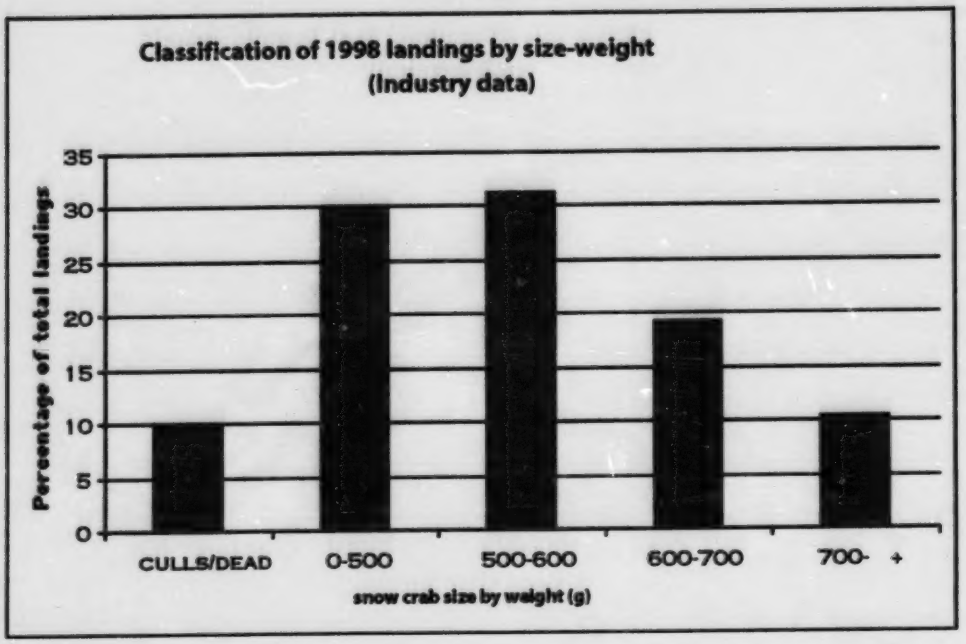


Figure 12. Reported logbook positions in 1999.



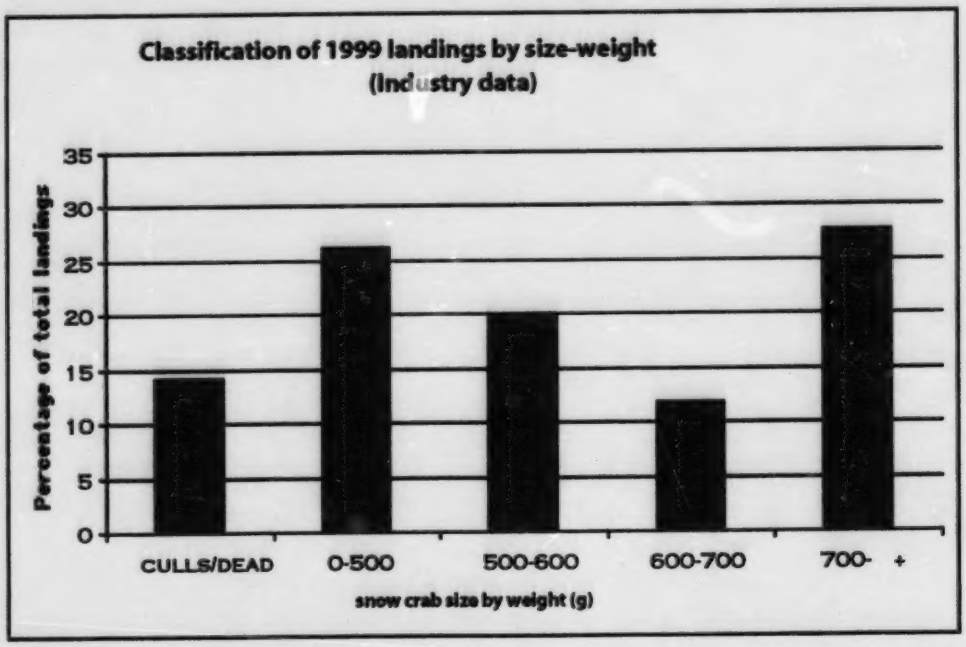
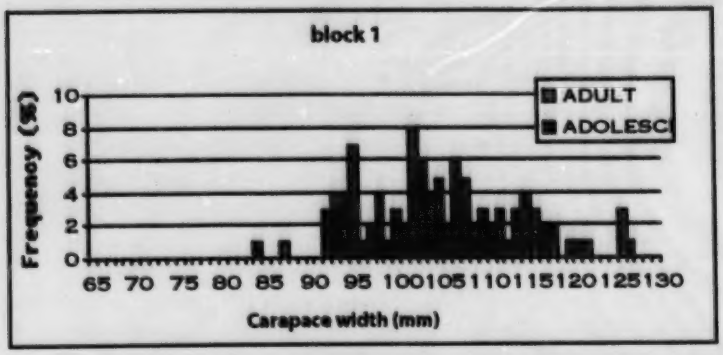
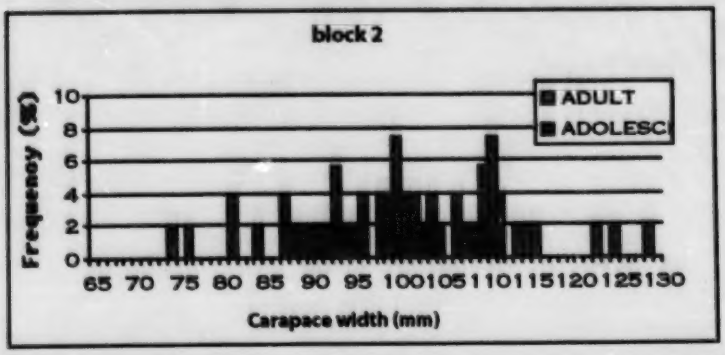
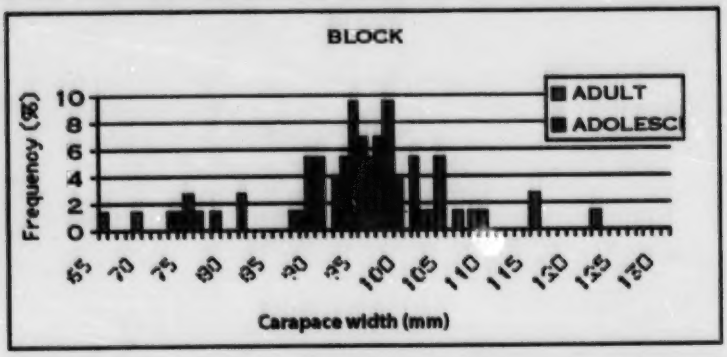


Figure 13. Snow crab landings classified by size-class by the buyer/processor in 1998 and 1999.







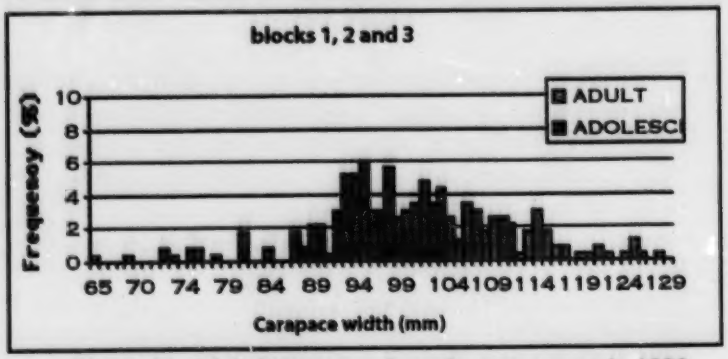


Figure 14. Male histograms from the trap survey in 1999.

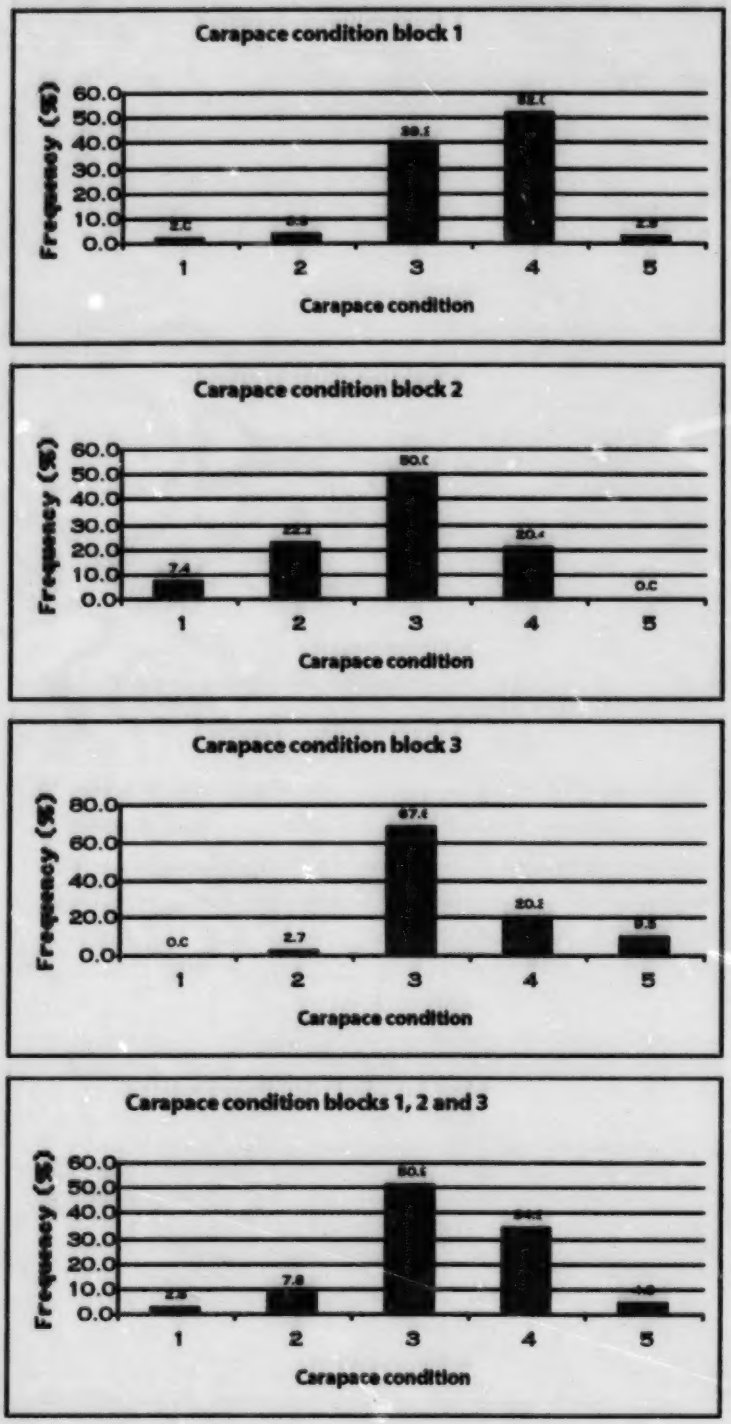


Figure 15. Carapace condition distribution from the trap survey in 1999.

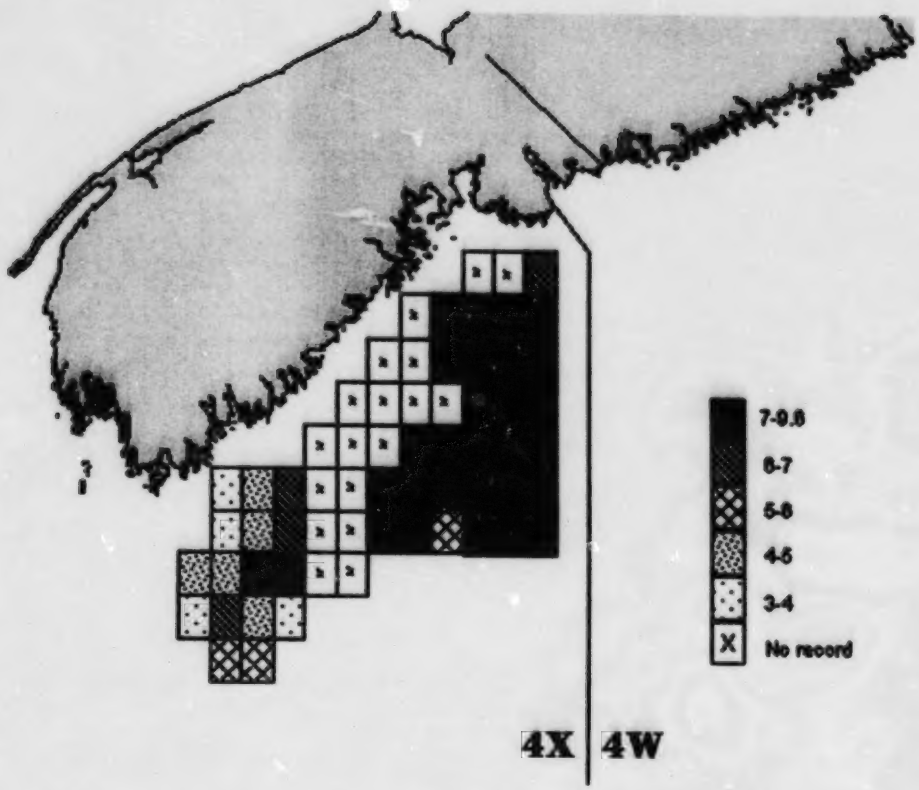


Figure 16. Temperatures recorded during the trap survey.

Appendix 1

Classification of carapace stages based on carapace condition, durometer reading and corresponding approximate age after terminal molt (modified from CAFSAC 1991; Anonymous 1994).

Category	Stage	Durometer reading	Carapace condition	Approximate age after terminal molt
New soft	I	< 68	brightly colored, iridescent, soft, no epibionts, chelae easily bent.	0-5 months
Clean	II	variable	brightly colored, some iridescence, may have epibionts, chelae not easily bent	5 months- 1 year
Inter-mediate	III	> 68	dull brown dorsally and yellow-brown ventrally, no irridescence, shell abrasion evident, epibionts.	8 months -3 years
Old	IV	> 68	carapace very dirty but hard, decay may be present at leg joints, epibionts removable at processing plant.	2 - 5 years
Very old	V	variable	carapace very dirty and may be soft (durometer reading < 68), progression of decay may be evident, epibionts not removable at processing plant.	4-6 years